

DETERMINATION OF TEMPERATURE AND CHEMICAL COMPOSITION PROFILES OF METHANOL OPPOSED FLOW DIFFUSION FLAMES.

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An opposed flow diffusion flame (OFDF) can arise in the stagnation boundary layer when an oxidizing jet impinges on a surface issuing a volatile fuel and an ignition source is introduced. Figure 1 illustrates the behavior of a typical OFDF. This configuration is frequently employed in experimental and numerical studies of laminar flames. The opposed flow or counterflow configuration is, according to Dixon-Lewis [1], the most appropriate configuration for the investigation of the composition and microstructure of laminar flames.

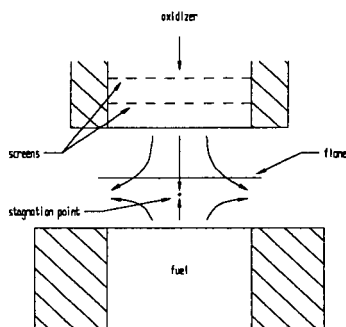


Figure 1

Chemical kinetic models are important tools for describing combustion systems. Measurements of combustion gases at temperatures higher than 1000K are complicated by the presence of fast reactions and the typically small size of the reaction zone. However, reaction mechanisms at higher temperatures are simpler and kinetic models can be validated for stable compounds with well-established measurement techniques. Reaction mechanisms for the oxidation of methanol, CH_3OH , were developed using data following from measurements involving shock tubes and turbulent flow reactors. These comprehensive mechanisms are discussed with some detail in [2, 3] and have been used to predict the oxidation of methanol for other flows. Extinction measurements for pure methanol OFDF's have been reported [4] and the influence of its presence in solutions with heptane and toluene on structure and flammability limits has also been examined [5]. However, measurements and models of structure for pure methanol OFDF's are not found reported in the published literature. Our measurements provide an opportunity to test the applicability of kinetic rate constants accompanying published comprehensive reaction mechanisms for methanol oxidation.

Measurements of temperature and stable species of CH_3OH opposed flow diffusion flames (OFDF's) are compared with profiles obtained by numerical methods, i.e. kinetic models. Combustion measurements are carefully undertaken with quartz microprobes and gas chromatography. An OFDF burner is used to generate stable axially-symmetric laminar diffusion flames. A mixture of oxygen (O_2) and nitrogen (N_2) is directed vertically downward and impinges on the flat, horizontal surface of a pool of liquid CH_3OH . Ignition of the CH_3OH vapor is used to initiate burning. See Figure 2. Continuous sampling using a gas sampling valve with a 250 μl sampling loop is employed. Low back pressures in the lines conveying the sampled gas to the gas chromatograph ensure reaction quench in the wake of the recovery shock in the probe, downstream of the sonic probe tip opening. These lines are heated in order to prevent the condensation of water and any other low boiling point liquids. Analysis is accomplished with single packed column separation employing HayeSep polymers. Temperature profiles are measured using Pt/Pt-10% Rh thermocouples and a precision x-y positioner. Measured temperature profiles are subsequently corrected for radiative losses.

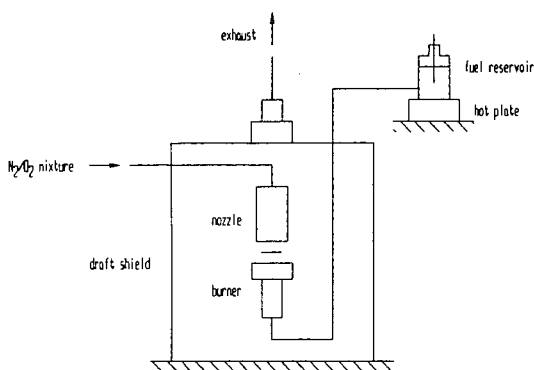


Figure 2

References

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